AP Chemistry, Semester 1
Unit Quiz: Chemical Reactions
Instructor's Version

Answers to Section I (Multiple-Choice Questions)

1.	**D**
2.	**C**
3.	**E**
4.	**D**
5.	**A**
6.	**C**
7.	**D**
8.	**C**
9.	**E**
10.	**C**

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Answers to Section II (Free-Response)
Time Limit: Students have 20 minutes to complete this section.
Scoring: 60 points total; question 1 is worth 30 points and question 2 is worth 30 points.
Calculator Use: Students may not use a calcutor for these questions.

1. Jessica finds six solutions in test tubes labeled A-F inside a box. The outside of the box has a label stating that inside there are six test tubes containing solutions of $AgNO_3$, $Fe(NO_3)_3$, $Ca(NO_3)_2$, NaCl, NaOH, and Na_2CO_3. Jessica knows that by using the solubility rules that she can make combinations of the solutions and identify the solution in each test tube. The results of Jessica's experiments are presented in the following table:

	A	B	C	D	E	F
A		No rxn	Ppt form	No rxn	Ppt form	No rxn
B			No rxn	Ppt form	No rxn	No rxn
C				Ppt form	No rxn	Ppt form
D					Ppt form	No rxn
E						No rxn

Based on these experimental results, identify solutions A-F. Explain your reasoning, using net ionic equations where appropriate.

Answer
Strategy: realize that Ca^{2+} precipitates only with CO_3^{2-}, Fe^{3+} precipitates with OH^- and CO_3^{2-}, and Ag^+ precipitates with Cl^-, OH^-, and CO_3^{2-}.
A: $Fe(NO_3)_3$
B: NaCl
C: Na_2CO_3
D: $AgNO_3$
E: NaOH
F: $Ca(NO_3)_2$

A + C: $2\ Fe^{3+} + 3\ CO_3^{2-} \rightarrow Fe_2(CO_3)_3$ (s)
A + E: $Fe^{3+} + 3\ OH^- \rightarrow Fe(OH)_3$ (s)
B + D: $Cl^- + Ag^+ \rightarrow AgCl$ (s)
C + D: $CO_3^{2-} + 2\ Ag^+ \rightarrow Ag_2CO_3$ (s)
C + F: $CO_3^{2-} + Ca^{2+} \rightarrow CaCO_3$ (s)
D + E: $Ag^+ + OH^- \rightarrow AgOH$ (s)

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2. Consider the following reaction: $Pb(OH)_4^{2-}$ (aq) + ClO^- (aq) → PbO_2 (s) + Cl^- (aq) in basic solution.

A. Determine the element being oxidized. What is its oxidation number as a reactant and as a product? (3 points)

Answer
Pb gets oxidized; oxidation number in reactant = +2; oxidation number in product = +4

B. Determine the element being reduced. What is its oxidation number as a reactant and as a product? (3 points)

Answer
Cl gets reduced; oxidation number in reactant = +1; oxidation number in product = −1

C. Write and balance the oxidation half-reaction in basic solution. (8 points)

Answer
$Pb(OH)_4^{2-}$ (aq) → PbO_2 (s) + 2 H_2O (l) + 2 e^-

D. Write and balance the reduction half-reaction in basic solution. (8 points)

Answer
ClO^- (aq) + H_2O + 2 e^- → Cl^- (aq) + 2 OH^- (aq)

E. Write the overall balanced net ionic equation in basic solution for this reaction. (6 points)

Answer
$Pb(OH)_4^{2-}$ (aq) + ClO^- (aq) → PbO_2 (s) + Cl^- (aq) + H_2O (l) + 2 OH^- (aq)

F. What is the reducing agent in this reaction? (2 points)

Answer
Pb gets oxidized so $Pb(OH)_4^{2-}$ (aq) is the reducing agent.

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